JPL

Control Center Technology Conference

JPL's
Space Flight Operations Center

Development Project Overview

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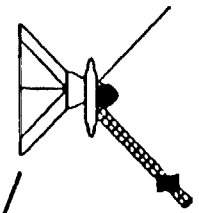
Major Elements
Deep Space Flight Programs

- Build and Launch Spacecraft
- Monitor Spacecraft Performance
- Plan Spacecraft Sequences/Operations
- Compute Spacecraft Trajectory
- Analyze Science Data

Provide
- Tracking Station Control/Monitor
- Ground Communications Control/Monitor
- Network/User Data Interface



Flight Projects
- Voyager
- Galileo
- Ulysses
- AMPTE
- Magellan
- Mars Observer

Space Flight Operations Center

Deep Space Network Facilities at JPL

Deep Space Complex
- Goldstone
- Australia
- Spain

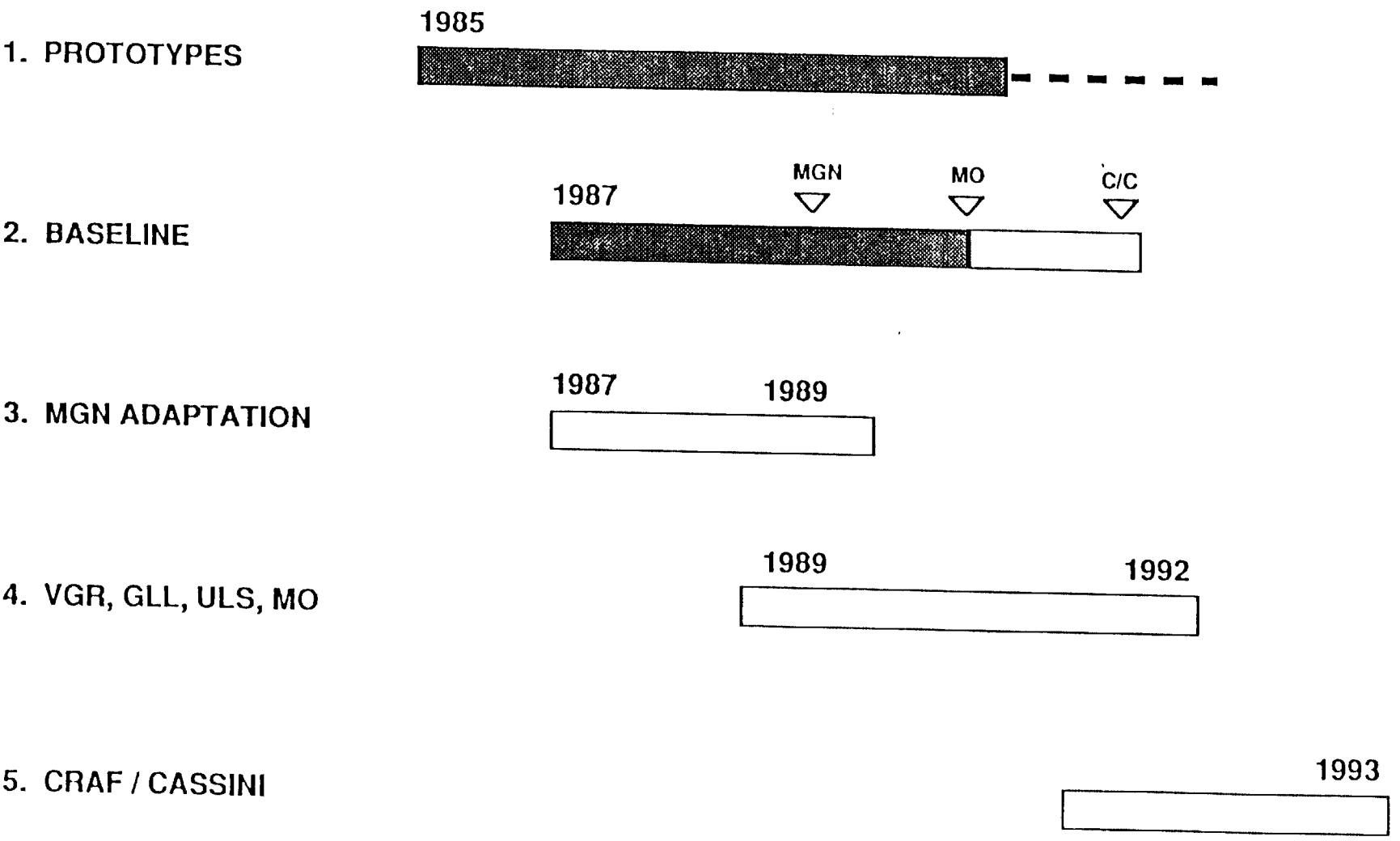
Provide
- Simulation System
- Telemetry System
- Command System
- Computing Environments
- Physical Facilities

Provide
- Antennas
- Low Noise Receivers
- High Power Transmitters
- Tracking Data Acquisition
- Telemetry Data Acquisition

Motivation and Historical Perspective

- The SFOC Development Project was conceived in 1984 to:
  - Develop a "Multi-Mission" Ground System to support present and all future Flight Projects
  - Develop Tools to Automate Labor-Intensive Processes
  - Modernize Computing and Information Services
  - Remove Unnecessary Overlaps in capabilities with Systems (FPSO vs. DSN)
  - Enable reductions in Operations Costs

DEVELOPMENT SCHEDULE



PRIMARY DESIGN GOALS

- Support New Missions: Magellan, Mars Observer, CRAF/ Cassini
- Support Current Missions: Galileo, Voyager, Ulysses
- Build SFOC using Distributed Architecture, Powerful Workstations, Centralized Distribution of Mission Data, and Network Communication
  - Data can be moved to wherever needed easily
  - Data can be analyzed by User- and Project-Software
  - Layered Design can Reduce Code Duplication
- Centralize Operations and Flight Support Personnel
- Design for 10-15 Year Life Expectancy

Technical Guidelines

Networks
Ethernet, TCP/IP

Off-The-Shelf Products, Multiple Vendor Platforms
X Windows, OSF/Motif, Sybase

Super-Microcomputers
68XXX, RISC

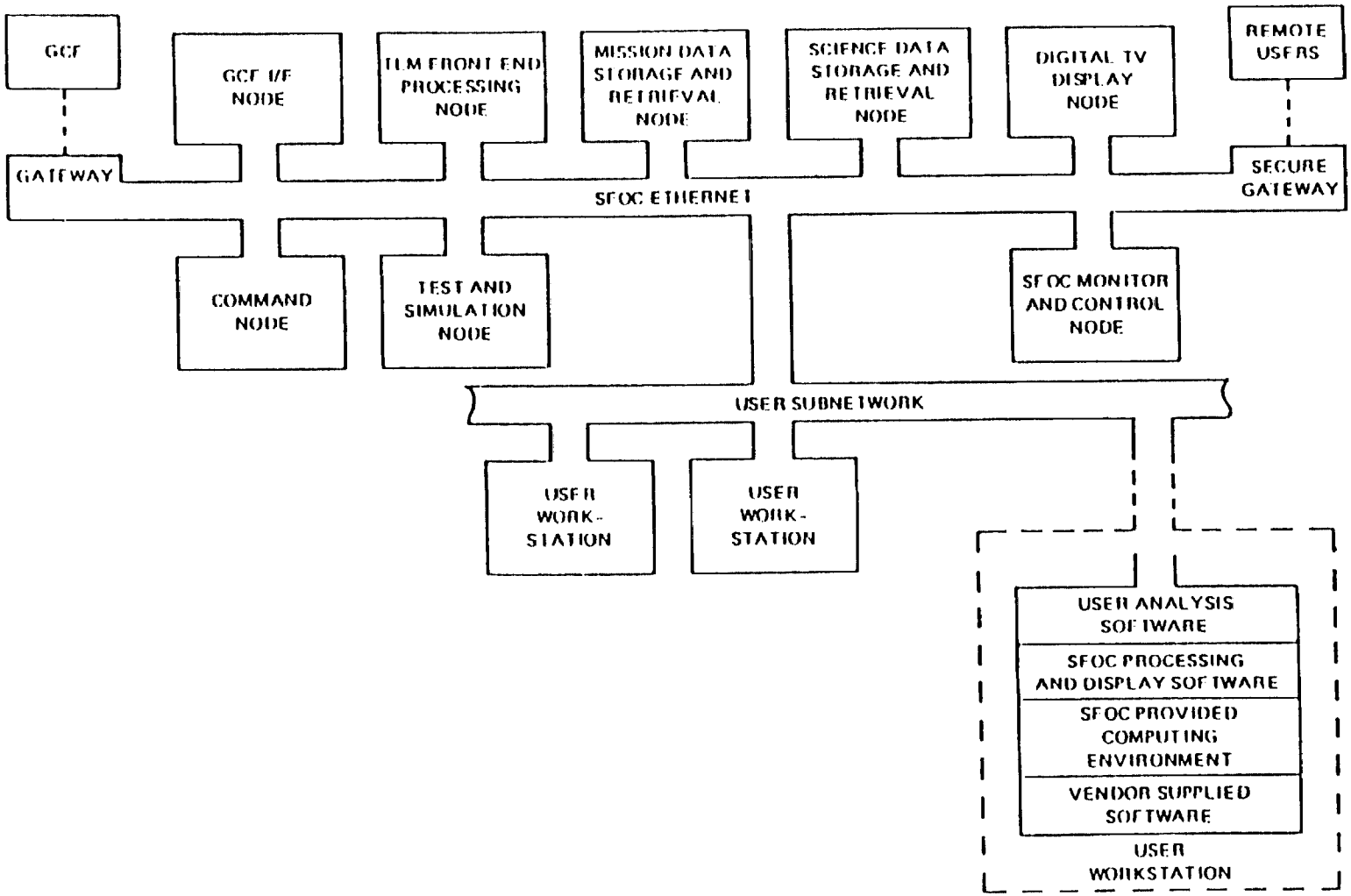
Common Operating System and Single Language
UNIX, C

Exploit Standards
Standard Formatted Data Unit (SFDU)

SFOC DATA SYSTEMS ARCHITECTURE

- Connectivity Via Network
- Centralized Distribution of Mission Data
- Remote User Science Data Exchange
- Centralized Ground System Monitor and Control
- Workstation Data Monitor and Display
- Ground System Test and Fault Isolation

SFOC
Data System Functional Architecture



Typical SFOC Node

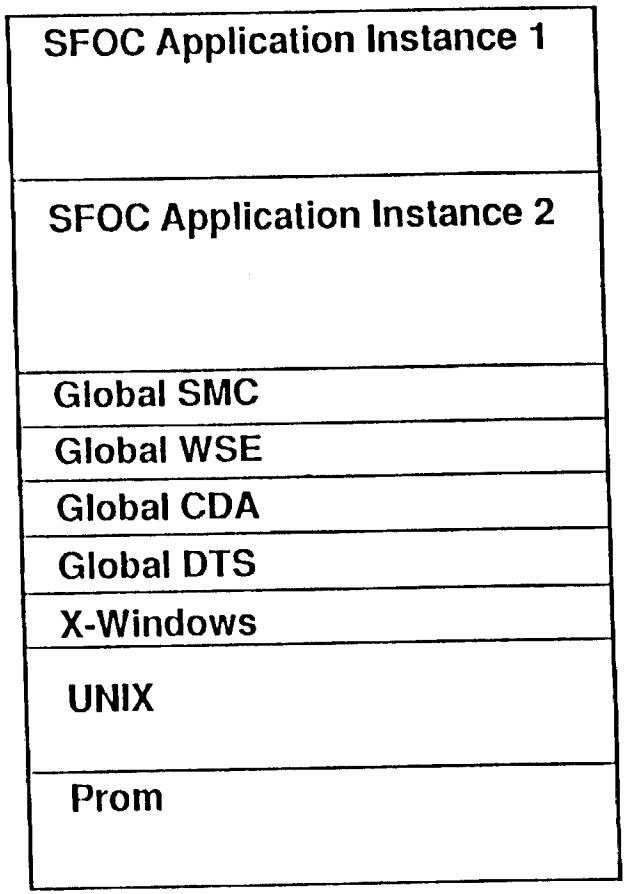
SFOC software applications (executables) contain compiled and linked software from a number of subsystem libraries such as DMD DTS, WSE, etc.

Global SFOC-provided software provides subsystem routines (operating system extensions).

- Process monitor and control. --
- Standard user interface and display. --
- Data storage and retrieval services. --
- Data transfer services. --
- X-Windows provides windowing and graphics environment. --

UNIX provides common services, process control and general hardware/software I/Fs. --

The Prom contains boot and diagnostic software. --

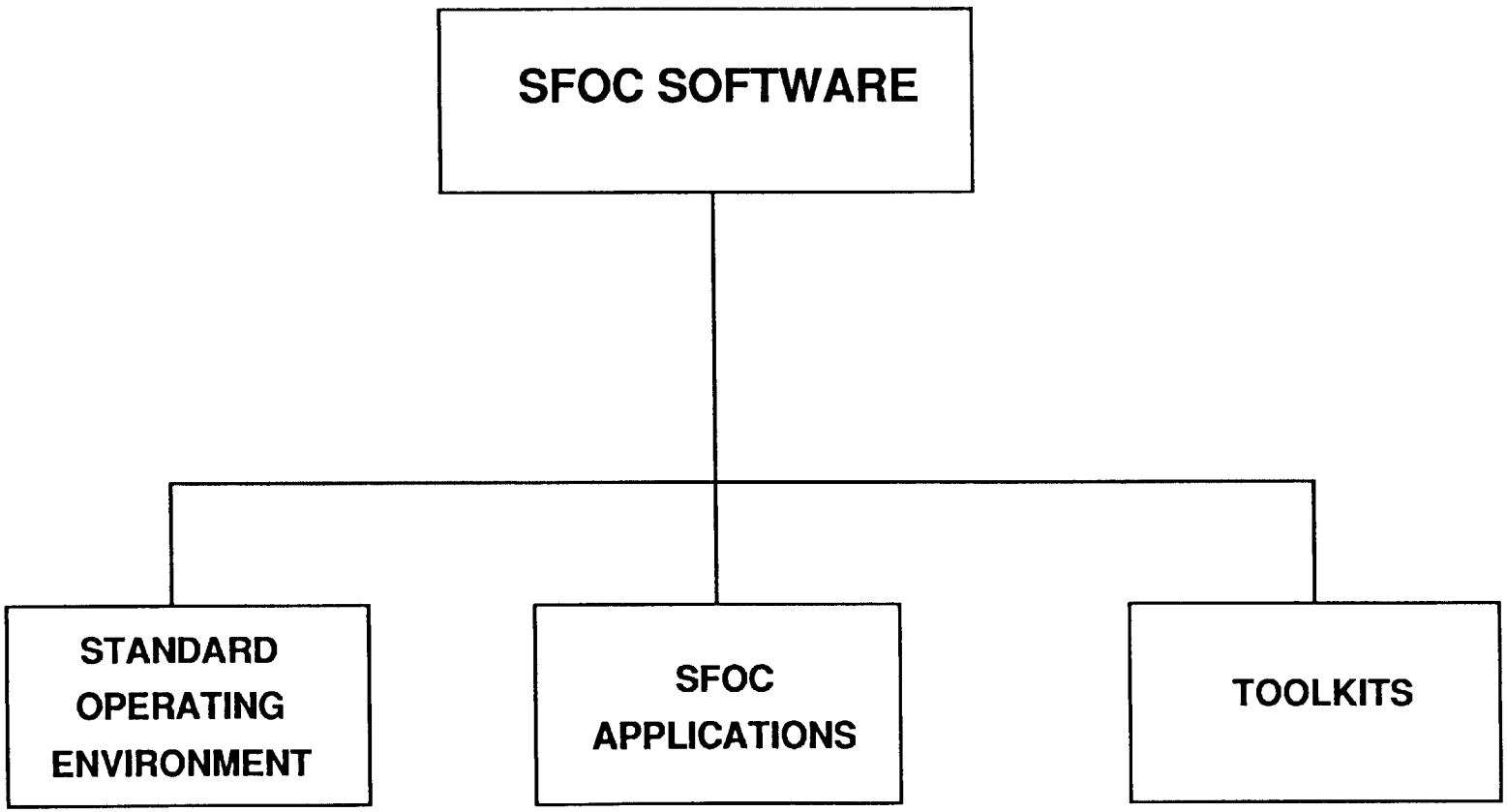


SFOC COMPONENTS

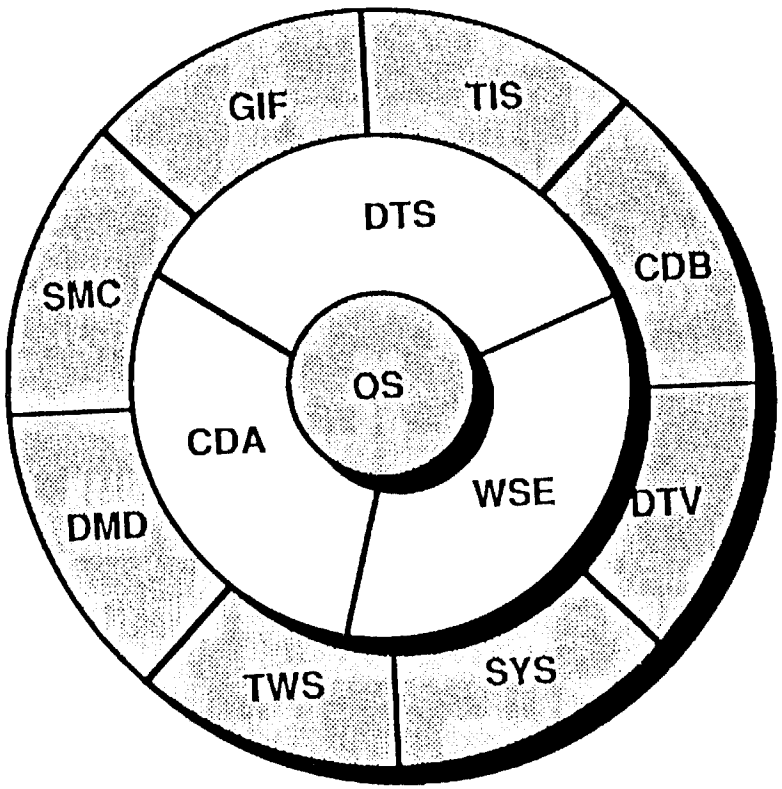
- Software
  - Vendor Software
  - SFOC Built Software
    - Baseline Capabilities
    - Project Adaptations

- Hardware
  - Vendor Hardware
  - Special Purpose Hardware

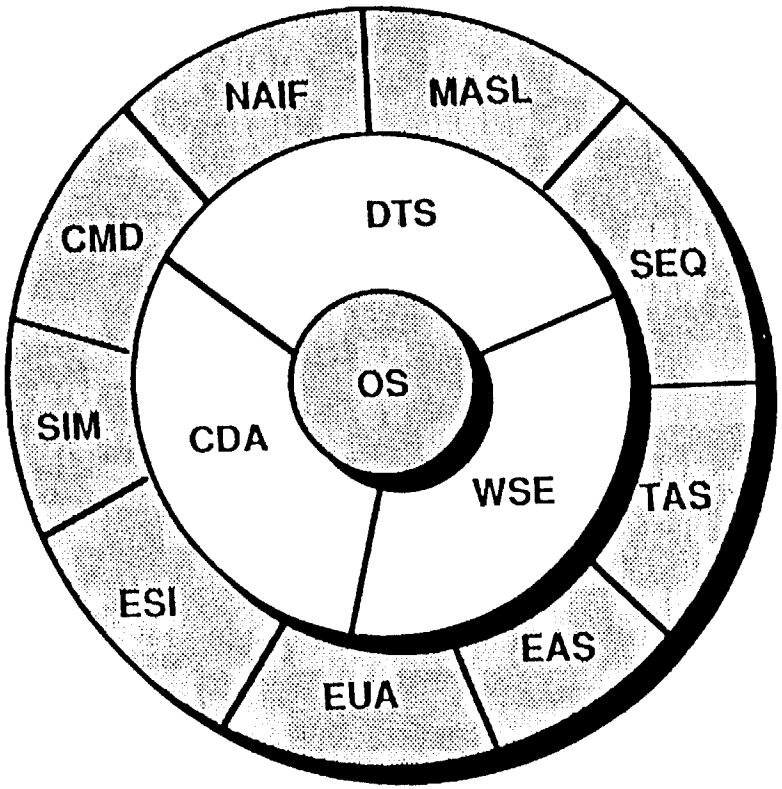
SFOC SOFTWARE CATEGORIES



PLANNED SUBSYSTEM CORE DIAGRAM FOR MARS OBSERVER



MGN ERA



MO ADDITIONS

SFOC Use of Public Domain/3rd Party Software

- Data Management
  - Sybase Relational DBMS
  - CISAM Indexed File Management
- User Interface
  - X Windows
  - Motif User I/F Toolkit
  - X Desk Top
  - Dataviews Graphics
- Network
  - Network Time Protocol - OSF DCE
  - Logical Name Service - OSF DCE
- Security
  - Kerberos - OSF DCE

SFOC HARDWARE

SFOC "Core" Subsystem Hardware

- Workstations
- Network
- Minor Special Purpose Hardware
- Gateways to Other Networks

Flight Project Mission Support Area Hardware

- Workstations
- Network
- Connections to Project Supplied Workstation

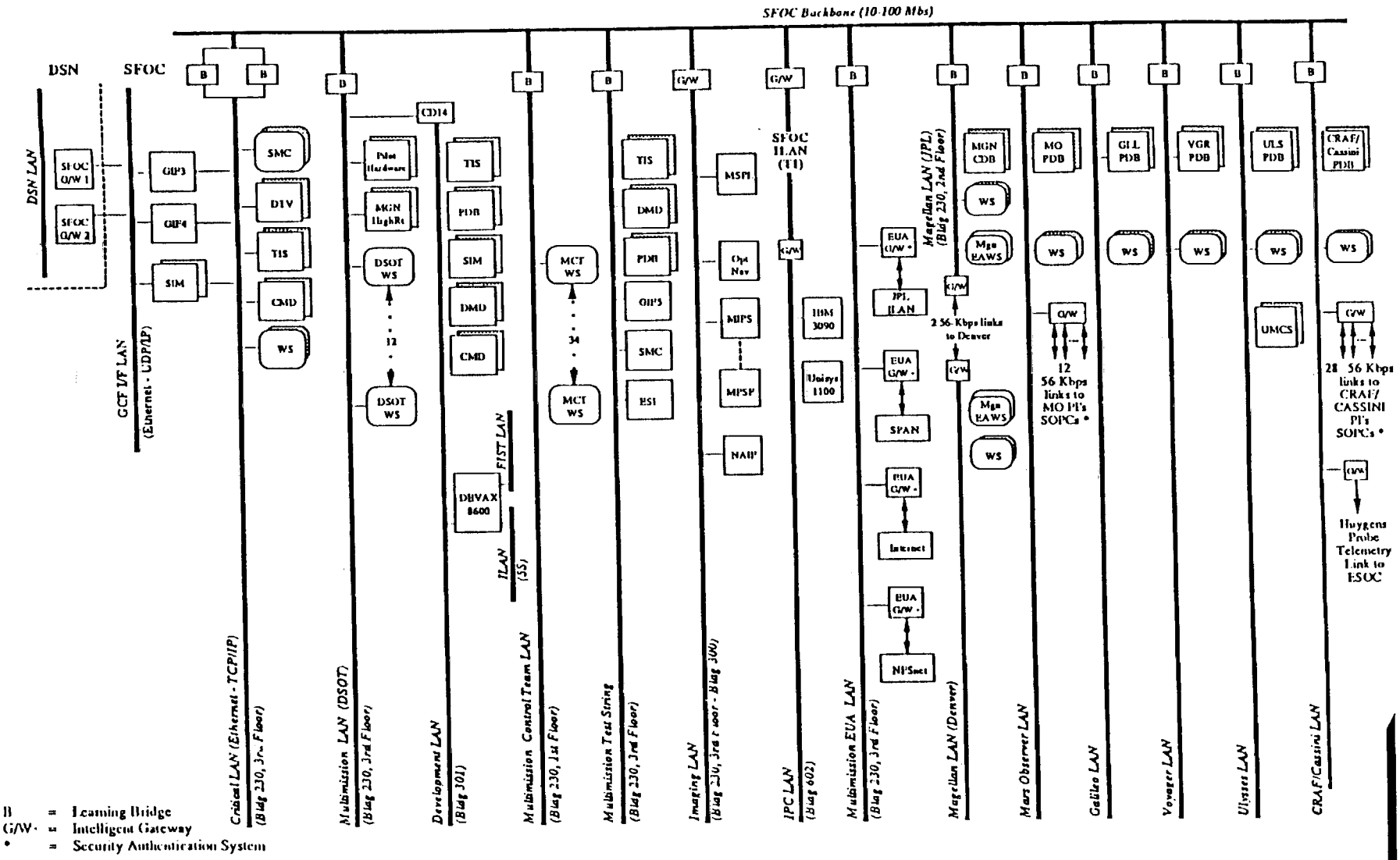
Connections to Existing Hardware

- MIPL
- UNISYS
- IBM 3090

Remote Sites

- Workstations
- Gateways

SFOC TARGET SIX MISSION CONFIGURATION



SFOC Technical Guidelines and Relation to MO & DA Development Costs

SFOC Characteristic	Cost Implication
Basic Distributed System Architecture	For 15 years no new 'SFOC", capabilities will be built on SFOC
Hardware "Platform" Independence	Obtain best computer price/ performance at time computers need to be obtained
Software Reusability	Provide Base of capabilities that can easily be adapted for future Mission support
Technology Assessment and Requirements clarification progress via Prototypes	Reduce development risk and avoid costly late change due to requirement uncertainty
Central Data Storage and Retrieval	Enables elimination of data records function

SFOC Characteristic and Relationship to MO & DA Operations Costs

SFOC Characteristic	Operations Cost Implication
Centralized Monitor and Control of Ground System Operations	Reduction in Operations costs for Data Delivery Function (DSOT)
Remote MSA Support via Networks	Enables "Stay-at-Home" Operations by S/C and Science Teams
Automate Labor Intensive Processes	Uplink tools result in Sequence Team Savings to MO, C/C
Workstation Displays	Enable Multi-spacecraft and/or Multi-Sub-systems Displays
Display Development Flexibility	Accommodates a Wide Range of User Types and Skills

SFOC Development Status and Plans

- SFOC Employs an Incremental Development Approach

Version 7 Supported Magellan Launch	- May 1989
Version 13 Supporting Magellan Orbital Operations	- May 1990
Version 16 in Test Includes Voyager, Ulysses and Mars Observer Capabilities	- Present
Version 17 Complete Mars Observer Launch Capabilities and Voyager Conversion to SFOC	- November 1991
Version 18 Complete Galileo Conversion to SFOC	- April 1992
Future Versions CRAF / Cassini GDS	- November 1993

SFOC METRICS

- Hardware
  - Presently Installed Workstations 158
  - Add'l to be Installed by 10/91 208
  - Total 356
- Software
  - Lines of JPL Developed Code 943,000
  - Estimated % Multi-Mission 90%